Aging Brain and Insulin Resistance

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Abstract

Brain aging is a natural process that is linked to reduced cognitive abilities, brain volume and neurochemical activity. There are many ways to slow this process down, one of them being diet. The question we seek to answer is "Can keeping a healthy weight and lower insulin resistance help prevent brain aging?". To answer this question, we conducted an analysis on data from an fMRI study of the aging brain on acute ketosis, using scatterplots to see if BMI vs HOMA and age vs HOMA are related.

Introduction

As we continue to age and develop, our brain does too. According to the National Institute of Aging (NIA), brain aging is a natural process that happens over time that affects cognitive function. With brain aging comes slower recall, diminishing working memory and multitasking abilities, deterioration of the myelin sheath, shrinking brain regions, and less production of neurotransmitters like dopamine and serotonin. Although brain aging is inevitable throughout our lives, there are ways to slow the process down such as getting an adequate amount of sleep, effectively managing stress, and engaging in mentally stimulating activities. For our report, we plan to look into how diet can play a factor in slowing brain aging. The question we seek to answer in our analysis is "Can keeping a healthy weight and lower insulin resistance help prevent brain aging?".

Our analysis may benefit anyone who is concerned about their aging brain and want to keep their brains young and healthy for longer than average. It would be especially beneficial for older and elderly adults since they have a higher risk of developing neurodegenerative diseases like Alzheimer's and Parkinson's disease, which can accelerate brain aging. Looking at body weight index (BMI) and HOMA-IR (Homeostatic Model Assessment for Insulin Resistance) scores would help us understand how diet is related to brain aging in different age groups. Analyzing these variables could help people realize what they should change in their diet by adding or subtracting certain foods in their meals. This would be a step in keeping the brain and body healthy as both are interlinked.

To answer our question, we plan to use the data from an fMRI study of the aging brain in acute ketosis. We plan to create scatterplots from the data to analyze the relationships between BMI vs HOMA and age vs HOMA.

##Data Processing and Cleaning

Import required Libraries through the requirements.R file and import uncleaned data.

Changes column names to a more uniform syntaxing for easier reference and removes unused varaiables from the dataset.

```
cleanData <- uncleanData[,!names(uncleanData) %in% c("HbA1c", "sex", "bodyweight")]
names(cleanData)[names(cleanData) == "fasting insulin"] <- "Fasting Insulin"
names(cleanData)[names(cleanData) == "age"] <- "Age"
names(cleanData)[names(cleanData) == "participant_id"] <- "Participant_ID"

print(cleanData)
```

```
## # A tibble: 101 x 5
##    Participant_ID   Age   BMI `Fasting Insulin` HOMA
##    <chr>          <dbl> <dbl>             <dbl> <chr>
##  1 sub-006           35  24.6               5.2 0.95
##  2 sub-010           24  22.6               9.8 2.27
##  3 sub-011           25  22.6               1.3 0.24
##  4 sub-012           34  23.3               7.7 1.65
##  5 sub-013           35  25.9               6.2 1.32
##  6 sub-015           35  25.1               5.4 0.91
##  7 sub-016           28  26.9              13.5 2.87
##  8 sub-019           24  23.8               7.7 1.64
##  9 sub-020           22  25.0               6.3 1.18
## 10 sub-021           23  23.2              10.3 2.16
## # i 91 more rows
```

Data

To perform our analysis, we used data from an fMRI study of the aging brain in acute ketosis, which was found from openneuro.org, an open-source platform with public datasets containing neuroimaging data. The study involved scanning participants in a fasted state before and after they were administered insulin or glucose bolus based on body weight. Our data consists of 101 participants, aged 21-79, with the variables, participant_id, age, sex, BMI, bodyweight, fasting insulin, HbA1C, and HOMA. To clean the data, we removed the variables irrelevant to our analysis (sex, bodyweight, and HbA1C).

```
source("00_requirements.r")
```

```
## Warning: package 'tidyverse' is in use and will not be installed
```

```
## Warning: package 'magrittr' is in use and will not be installed
```

```
source("DataProcessing_Cleaning.R")
```

```
## Warning: package 'tidyverse' is in use and will not be installed
## Warning: package 'magrittr' is in use and will not be installed

## Rows: 101 Columns: 8
## -- Column specification --------------------------------------------------------
## Delimiter: "\t"
## chr (2): participant_id, HOMA
## dbl (6): age, sex, BMI, bodyweight, fasting insulin, HbA1c
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.

## # A tibble: 101 x 5
##    Participant_ID   Age   BMI `Fasting Insulin` HOMA
##    <chr>          <dbl> <dbl>             <dbl> <chr>
##  1 sub-006           35  24.6               5.2 0.95
##  2 sub-010           24  22.6               9.8 2.27
##  3 sub-011           25  22.6               1.3 0.24
##  4 sub-012           34  23.3               7.7 1.65
```

```
##  5 sub-013           35  25.9              6.2 1.32
##  6 sub-015           35  25.1              5.4 0.91
##  7 sub-016           28  26.9             13.5 2.87
##  8 sub-019           24  23.8              7.7 1.64
##  9 sub-020           22  25.0              6.3 1.18
## 10 sub-021           23  23.2             10.3 2.16
## # i 91 more rows
```

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- Prelim visualization
- What do they suggest about the hypothesis, model, or sim we are trying to perform? Our data includes word HOMA, BMI. HOMA is a score combining glucose + insulin. Higher the HOMA = Bad glucose fuel. Bad glucose fuel = higher insulin resistance. -Brain's activity is depends on glucose, its main fuel source. if we have bad glucose fuel, it leads to brain aging faster. We had two hypothesis. first one is "if age is older then HOMA will be increase"

Visualization and Analysis

HOMA is a score combining glucose + insulin. when HOMA is high that means bad glucose fuel(insulin resistance) which can relate to brain aging.

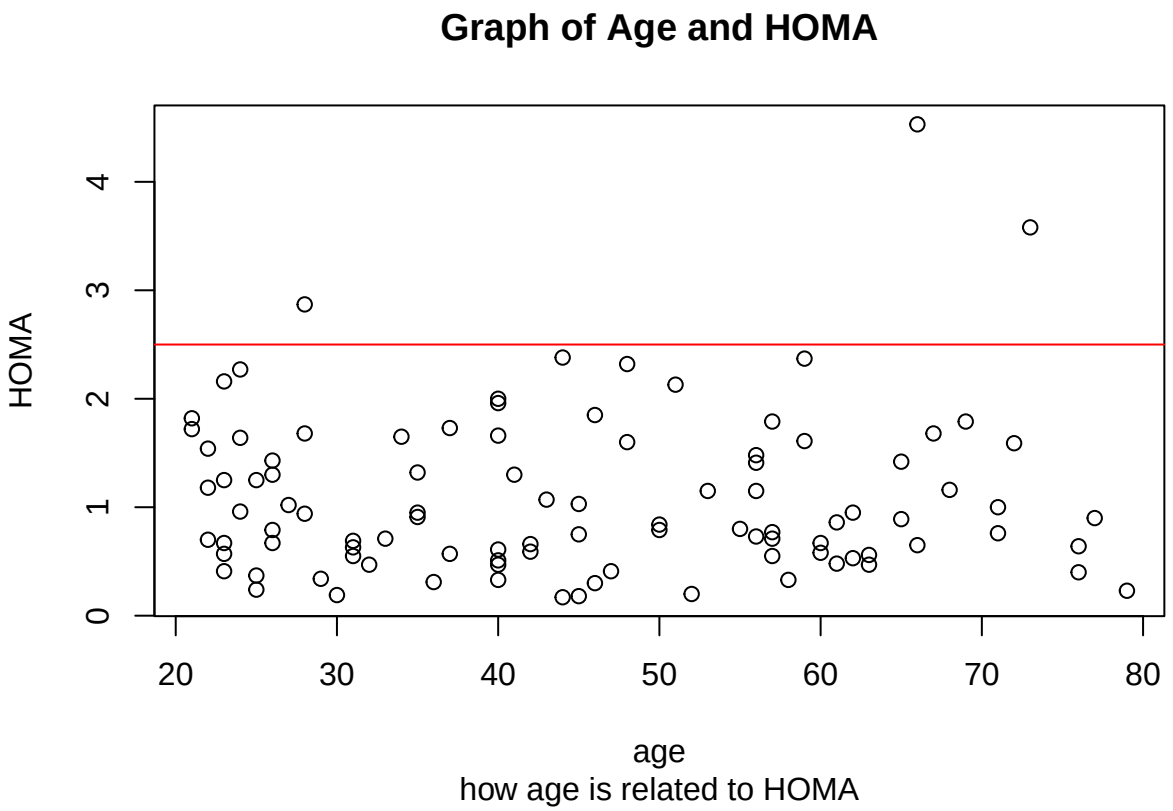
Hypothesis1: "if age is older then HOMA will be increase"

Create scatter plot to visualize the age relate to HOMA.

```
plot(x = cleanData$Age , y = cleanData$HOMA , xlab = "age", ylab = "HOMA", main = "Graph of Age and HOMA
```

```
## Warning in xy.coords(x, y, xlabel, ylabel, log): NAs introduced by coercion
```

```
abline(h = 2.5, col = "red")
```



According to scatter plot of age and HOMA, we can observe HOMA is not really affected by age. Red line indicates high HOMA which means faster aging, yet data shows HOMA is not really related to age.

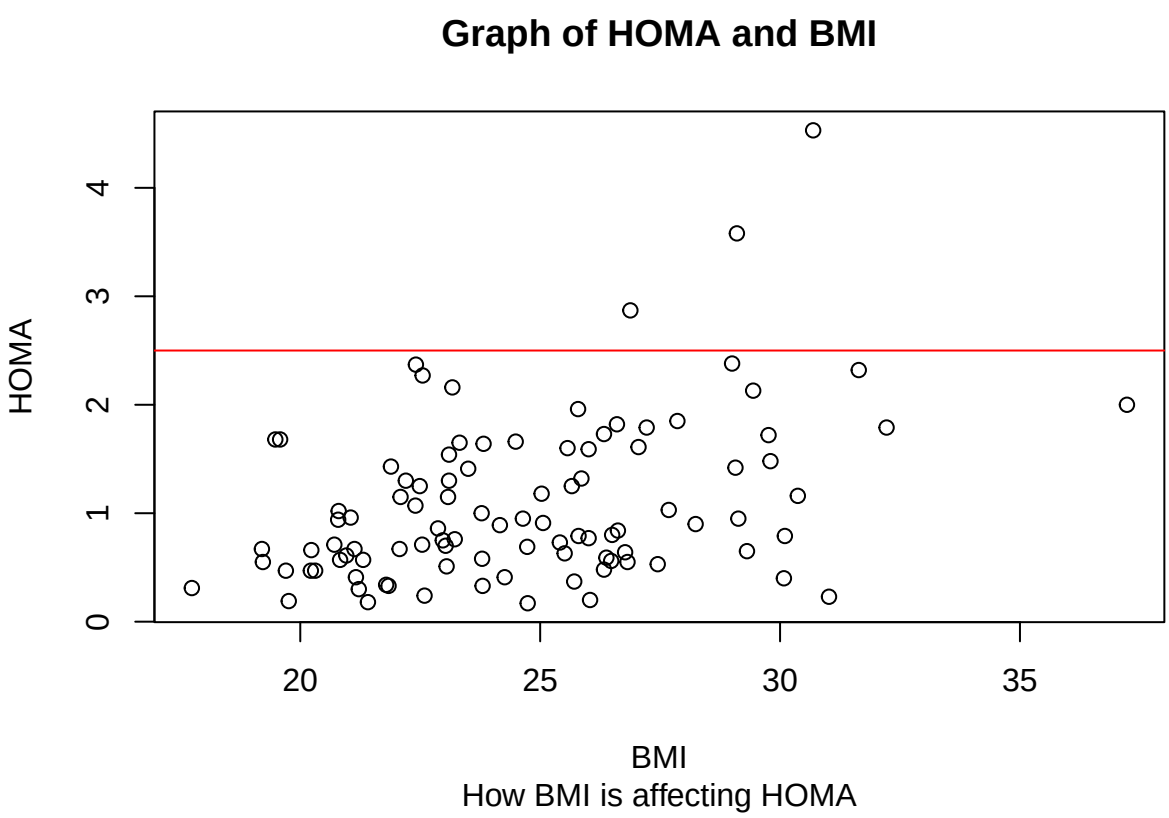
Hypothesis2: if BMI is higher, does HOMA increases as well.

Create the scatter plot displays BMI with HOMA.

```
plot(x = cleanData$BMI , y = cleanData$HOMA, xlab = "BMI", ylab = "HOMA", main = "Graph of HOMA and BMI
```

```
## Warning in xy.coords(x, y, xlabel, ylabel, log): NAs introduced by coercion
```

```
abline(h = 2.5, col = "red")
```



Shows higher the BMI, HOMA tends to increase as well. Red line indicates high HOMA. According to scatter plot, as BMI increases, HOMA increases as well.

high HOMA which can be high insulin resistance = glucose fuel less efficiently - brain's activity is depends on glucose, its main fuel source. - less efficient it is, there is high possibility that brain can aging faster.

Expected outcomes for age & HOMA, we are expecting older the age = higher the HOMA for hypothesis 1, and for BMI & HOMA, we are expecting higher the BMI = higher the HOMA according to data we have and visualized scatter plot graph, we could observe age is not really related to HOMA, yet BMI is relevant to HOMA. As BMI increases, HOMA increases as well.

Conclusions

Age was not really matter to HOMA, while BMI was affecting HOMA. Since we mentioned about how high HOMA = Bad glucose fuel = higher insulin resistance, and how brain's activity is depends on glucose that is the main fuel source. Higher the BMI can leads high HOMA that will affect brain from aging faster. At the same time if BMI is normal or lower, it can give better insulin sensitivity that can leads to healthier brain = insulin works well with healthy BMI; brain gets steady fuel supply. According to our prompt: "Can keeping a healthy weight and lower insulin resistance help prevent brain aging", based on data we have, we can answer our prompt: yes, keeping a healthy weight gives healthy BMI that supports lower insulin resistance do help prevent brain aging.

Member Contribution

Jonathan Wu - Formatting, Cleaning, ReadME Sung Woo - Data Visualization, Analysis Christie Wong - Report(Abstract, Intro, Data)